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per cent. Jupiter's deviation is about 2.6 per cent.; Saturn's, 1.2 per cent.; Uranus's, 1 per cent.; Earth's, $\frac{1}{5}$ of 1 per cent. The co-efficient-products in the three principal planetary pairs are, ♀ ⊕, $\frac{1}{2} \times \frac{2}{3} = \frac{1}{3} =$ nodal division of linear pendulum; ♃ ♄, $\frac{5}{6} \times \frac{6}{7} = \frac{5}{7}$, nearly $= 2\, r \div$ kinetic radius; ⛢ ♆, $\frac{7}{8} \times \frac{8}{7} = 1$. It seems probable that the actual determining orbit was an ellipse, the two foci being within the masses of Sun and *a Centauri*, but the difference between parabolic and elliptical co-ordinates in our planetary system, is not recognizable so near the focus.

Improved Mounted Burettes for Volumetric Analysis.

BY J. BLODGET BRITTON.

(*Abstract of remarks made before the American Philosophical Society, December 3d,* 1875.)

More than a year ago (meeting of November 20th, 1874, Vol. XIV, No. 93, p. 189, of the published proceedings) I exhibited several burettes mounted on stands, and delicately graduated for close, volumetric analysis, differing from each other, but each having the screw and spring valve adjustment, and also one of the rod-stoppered kind, having the screw and top spring lever adjustment.

I now exhibit and shall explain three others also mounted, and delicately graduated, yet still more improved.

The shortest one (Fig. 1 in the annexed plate), has a capacity of 100 cc, with its scale divided into tenths, or one thousand degrees. The glass rod inside of the tube is operated by means of a thumb-screw (A) which works against a horizontal lever (B) under the stand. The lower end of the light vertical iron rod (C) inside of the wooden upright of the stand, rests upon the front of the lever, and its upper end encircles the glass rod directly under its knob. By turning the thumb-screw, the iron rod, and with it the glass one, may be raised or lowered, and the vent of the burette opened or closed at pleasure. The flow may thus be completely controlled or instantly stopped.

The second instrument (Fig. 2 in the plate) is between four and five feet long, and has a capacity of 240 cc, with its scale divided into tenths or two thousand four hundred degrees. It is operated with the thumb-screw (A) like the shorter instrument from which it differs in construction only in the position of the screw and lever and shape of the latter. The screw is placed

Fig. 1.

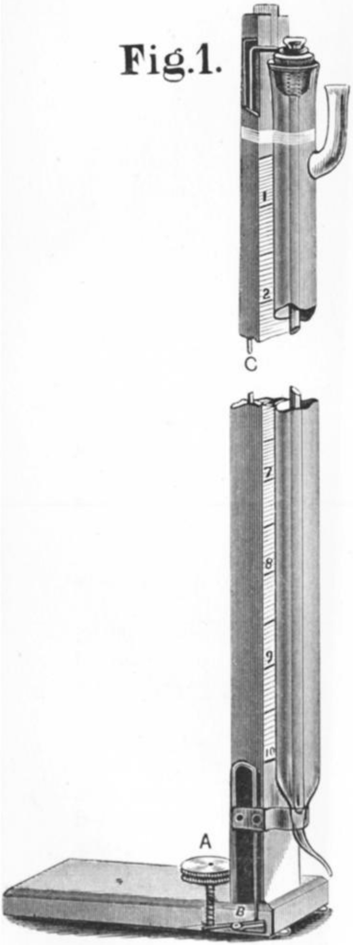


Fig. 2.

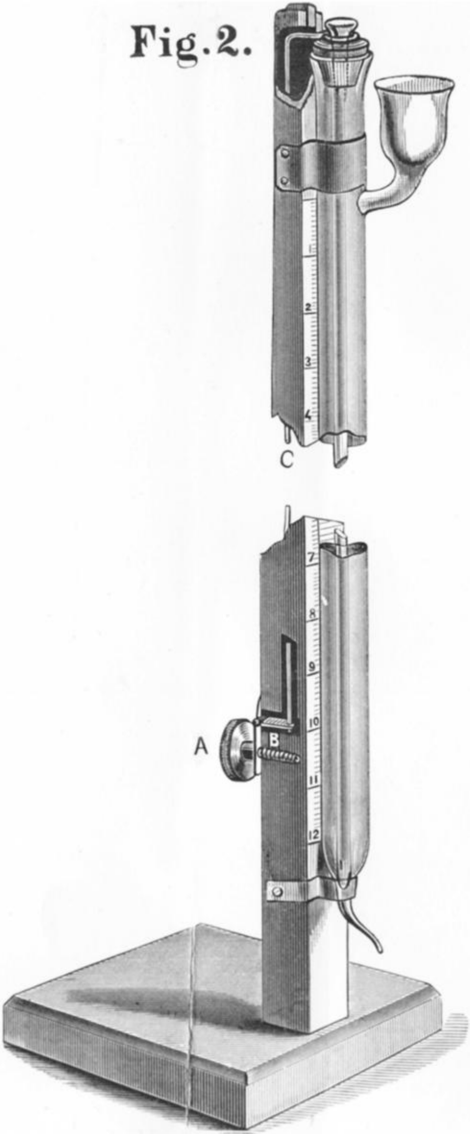


Fig. 2.

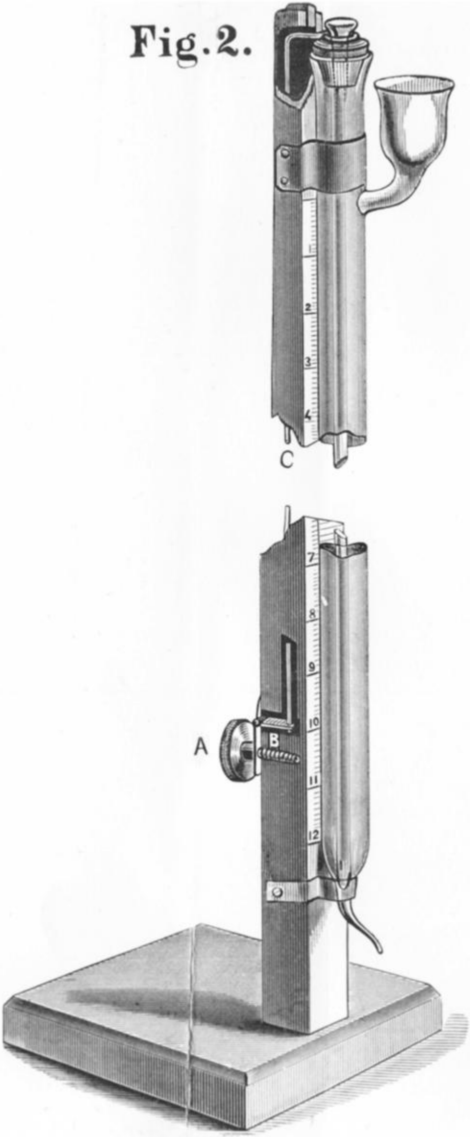
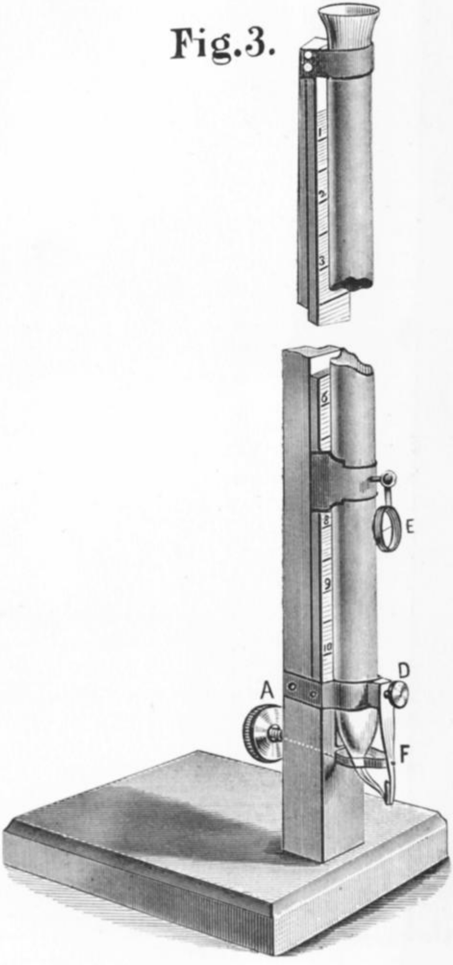


Fig. 3.



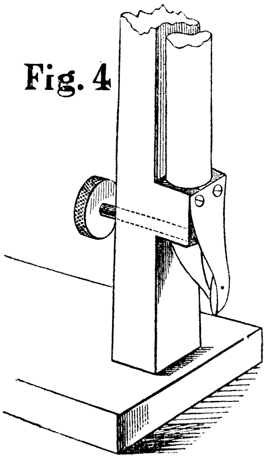
high up on the upright to allow it to be conveniently grasped when the instrument is being adjusted for use. The eye must at that time be raised to a level with the 0 point of the scale to watch the fluid fall gradually to exactly that point. Should the screw be more than about thirty-four inches below, the hand could not reach it to make the adjustment, its position must therefore depend upon that of the 0 point or length of the instrument.

A short burette should have its thumb-screw placed at or near the bottom of the stand (as shown by Figs. 1 and 3 in the plate) to afford a solid rest for the hand while operating; such a rest will prevent any nervous trembling of the thumb and finger when cautiously shutting off the finishing drop.

When it becomes necessary to use a strong acid or caustic alkali, and the analytical work is to be done with great accuracy, I believe that these burettes will give full satisfaction. There is no metal or organic substance about them with which the fluid can be affected—nothing but glass. Leaking to any annoying degree does not occur when the rod is not too light and care is taken to exclude from the tube any granular or solid matter that would prevent the rod from shutting down close; the joint must of course be properly ground, and the opening not too large; but should leaking occur regrinding may be done in two or three minutes by dropping into the tube a few grains of emery flour with some water, and then turning the rod sharply round and round, alternately lifting and pressing it a little. It is best, however, not to neglect to make a note of the reading for any length of time after it can be done correctly. The long instrument will be found very serviceable in a laboratory where many consecutive determinations are to be frequently made, for one filling will answer for several, though it is rather cumbersome for only occasional work, and ordinarily the short one will be preferred. They are exhibited together to illustrate the two ways of placing the thumb-screw and lever.

The third instrument (Fig. 3 in the plate) is of the kind I have had in use for about ten years, and with which a great many thousand iron determinations have been made, always working very satisfactorily. Two of them of different patterns were described in the *Journal of the Franklin Institute* for May 1870, and in the London *Chemical News* for July 5th, of same year. The one now exhibited has a capacity of 100 cc, with a delicate graduation, and is about forty-three inches long, the thumb-screw being nearly thirty-three inches from the 0 point of the scale, and near enough to the bottom of the stand to afford a rest for the hand. It has two improvements, one of which is an adjustable plano- convex lens (E) secured by movable joints to a light, metallic frame. The frame is made to slide up and down easily in grooves on the sides of the upright, and has on its right side a vernier. This arrangement permits the scale to be read with extreme precision, and when not required as in ordinary technical work, it may be slid entirely off, and laid aside. The other improvement, which is a minor one, consists of a single, small thumb screw (D) to hold the spring valve (F) in place, while at the same time it allows the valve to be taken off very conveniently when necessary to remove any matter choking the vent, and afterwards to be as conveniently replaced. The old arrangement (Fig. 4) required two screws, for the removal of which a screw driver was necessary. I, however, have not adopted the new to the complete expulsion of the old, which costs but a trifle, and in some respects is excellent.

Fig. 4



NOTES. Each of these burettes, it will be observed, has its graduated scale on white paper firmly pasted against the upright and behind the tube, and not cut on the tube itself; the graduation consequently is as distinct as it is possible to make it, and the reading being *over* the fluid, which affords a *level* to guide the eye, is done with the least liability to error. In this manner the finest of my burettes have been made. When the cutting is on the tube, I prefer it to be behind, and not in front, and well rubbed with lampblack and oil, and have a white paper pasted on the upright for a ground to make it more plainly seen.

Each tube has its lower end drawn out small enough to just allow a stout hog-bristle to pass freely in and out of the vent, and in order that the discharge may be made sufficiently far over into the receiving vessel, it is bent outwards with the point downwards, so that the vent shall be an inch and a half from the upright, and three inches from the bottom of the stand. The rod-stoppered tubes have their points made smooth by fusion, but the spring valved have theirs carefully ground on an emery plate to allow the valves to shut quite true and tight with the line of contact just vertical, and not at an angle.

Unnecessary thickness of glass about the points is avoided, and the valves are made small, especially at their lower ends, to give as little surface of material as possible for the retention by capillary attraction of the dropping fluid. To further obviate such retention, my practice is to occasionally rub the points and valves with a little pure tallow, the effect of which is excellent. Burettes made in the manner described, may with their valves wide open be discharged of 100 cc in about two minutes. But when there is a rapid discharge, a considerable quantity of the fluid is held back on the walls of the tube by attraction, and the quantity so held becomes increased with increased rapidity of discharge; this is shown most distinctly when a strong solution of chameleon is used, for the material gives color to the tube so long as any of it remains. A rapid discharge consequently will not permit a prompt reading, and if the tube be long some minutes must elapse before all of a fluid, of any considerable density, reaches the bottom. The case, however, is different when the discharge is moderately slow and uniform; the reading may then be done usually soon after the reaction has been effected. Against hasty work, therefore, beginners should be specially cautioned, and a slow discharging instrument would be best in their hands

I have experimented in years past, as stated at a former meeting, with valves made of quite a number of substances, hard and soft. Of the hard sort, glass when ground true and cushioned behind, afforded a tighter joint than metal, and gave altogether the most satisfaction, but still with ordinary every day usage would not keep in order, and withstand the pressure of a full column of fluid without leaking more or less. Of the soft sort, rubber and fine grained cork were the best; the latter proved most excellent when solutions of potassium permangenate and bichromate were used, for, while always giving a perfectly tight joint, and being sufficiently durable, it became *absolutely inert, and never got sticky from applications of tallow* like rubber. Cork has been in use at the Iron-Masters' Laboratory constantly since 1866, and I still prefer it for my purposes; when cut perfectly true and rubbed with tallow, it will make a valve from which globules no larger than the head of an ordinary pin can be discharged at will. I attach it to the spring with a rivet, and sometimes with a cement; for attaching thin rubber I have used a cement and also a benzine solution of rubber. For springs I have used platinum, brass, steel, and common tin plate.

Of the instruments exhibited, the rod-stoppered kind have the advantage of universal application, but the spring valved kind have more solidity and compactness, and will bear much rougher usage.

The one described by George A. Kœnig, Ph. D (Vol. XIV, No. 93, p. 218, of the published proceedings) is the short, graduated tube furnished by the dealers. to which is fitted the thumb-screw, and spring valve adjustment, the screw working through the spring, and not against it. It is not permanently mounted, and must be used like the one long ago proposed by Mohr (See side view Fig. 5). He states that by putting a hinged joint to the spring he has been enabled to use a platinum valve with a 30 cc tube, the delicacy of the hinge though, was found to be an objection, making the valve liable to get out of order. He further states that a spring coated with rubber will resist the action of standard acids. The instrument is substantially what had been produced years before, and, as must be obvious, is not so perfect as the permanently mounted one.

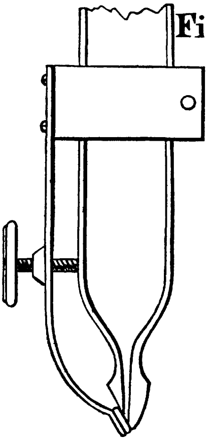


Fig. 5